Chapter 2
Preparation for Operation

Section I
Chassis and Body Components

SPECIAL CONSIDERATIONS

As described in Chapter 1, cold weather can cause problems with equipment not normally encountered during operations in temperate conditions. This chapter contains added information to consider when conducting vehicle/equipment before-operations PMCS.

BEFORE-OPERATIONS CHECKS

Ensure that added care is taken during before-operations checks. Never touch cold metal parts with your bare hands. Brush snow or wipe water from the tops of fuel and lube containers, spouts, and plugs before using to prevent contamination.

Wheel Bearings

Wheel bearings should be checked for looseness and proper adjustment. No change of lubricants is required, since all wheel bearings are serviced for year-round operations with grease, automotive and artillery (GAA), which has a temperature range of from -65°F to +225°F.

Hydraulic Brakes

Check the reservoir of hydraulic brakes for proper fluid level. No seasonal change of fluid for hydraulic brake systems is required. Brake fluid, silicone (BFS), should be retained in the system for all-season use.

Air Brakes

Frozen moisture in the air brake system seriously affects operation. Brake lines, air brake filters, brake chambers, pushrods, valves, and seals are subject to more defects and failure in cold. Condensation between brake shoes and brake drums may freeze, making it impossible for the vehicle to move. When this happens, use portable heating equipment to thaw the brake shoes from the drums. Ensure the alcohol evaporator kit, if part of the system, is functioning. Check brake lines, brake chambers, relay valves, pushrods, seals, and slack adjusters. Check air compressor, unloader valve, and governor for good condition and satisfactory operation. With the air pressure at the governed maximum and the brakes applied, stop the engine. There should not be a noticeable drop in pressure within one minute. Drain reservoirs immediately after operation, and close drain cocks immediately after draining to prevent freezing in the open position. In the morning, build up pressure before moving the vehicle. Make certain that the alcohol evaporator jar is filled with alcohol or the desiccant cartridge is serviceable. During scheduled service, clean brake pads. Remove oil and grease from units to avoid hardening and splitting. This helps to ensure a good air seal under pressure.

The new fleet of Army vehicles--including the family of medium tactical vehicles (FMTV), heavy equipment transporter (HET), palletized load system (PLS), and high mobility multi-purpose wheeled vehicle (HMMWV) heavy variant--have central tire inflation systems (CTIS) that operate off an air compressor. It is not unusual for air valves to freeze resulting in locked brakes or flat tires.

CAUTION

DRAIN WATER FROM AIR FILTERS AND RESERVOIRS AFTER EVERY EIGHT HOURS OF CONTINUOUS OPERATION.

Steering Gear

Improper lubricant congeals, thereby making steering difficult or impossible. Hydraulic power steering reservoirs should be filled with hydraulic fluid, petroleum base, (OHT), or OEA, and not Dextron II. Examine arms, tie rods, drag links, seals and boots, pitman arm, gear column, and wheel for good condition and secure mounting.

Shock Absorbers

Shock absorber fluid congeals in sub-zero temperatures, resulting in a hard-riding vehicle or broken shock absorbers. Make certain shock absorber bodies are securely mounted to the frame. Replace shock absorbers if they are leaking or if their action is unsatisfactory. To prevent damage to the shock absorber, the operating rod, or the mounting brackets during extreme cold, operate the vehicle slowly for the first three to five miles. This allow the oil in the shocks to warm up.

Track and Suspension

Ice and snow adhere to tracks, hindering operation. Cold contracts metals and makes rubber brittle. When operating in snow-covered and icy terrain, remove track pads as the commander directs, and/or employ traction aids (such as reversing every third track center guide). Remove dirt and ice and inspect for good condition and proper lubrication. Check track adjustment. Do not adjust tracks too tightly in a warm shelter, since they contract and break easily in temperatures of -40°F and below. Adjust track so that the slack is 50 percent greater than that specified for normal operation in the vehicle TM (Figure 2-1). Another method is to allow the vehicle and track to cool to outside temperature before making adjustments.

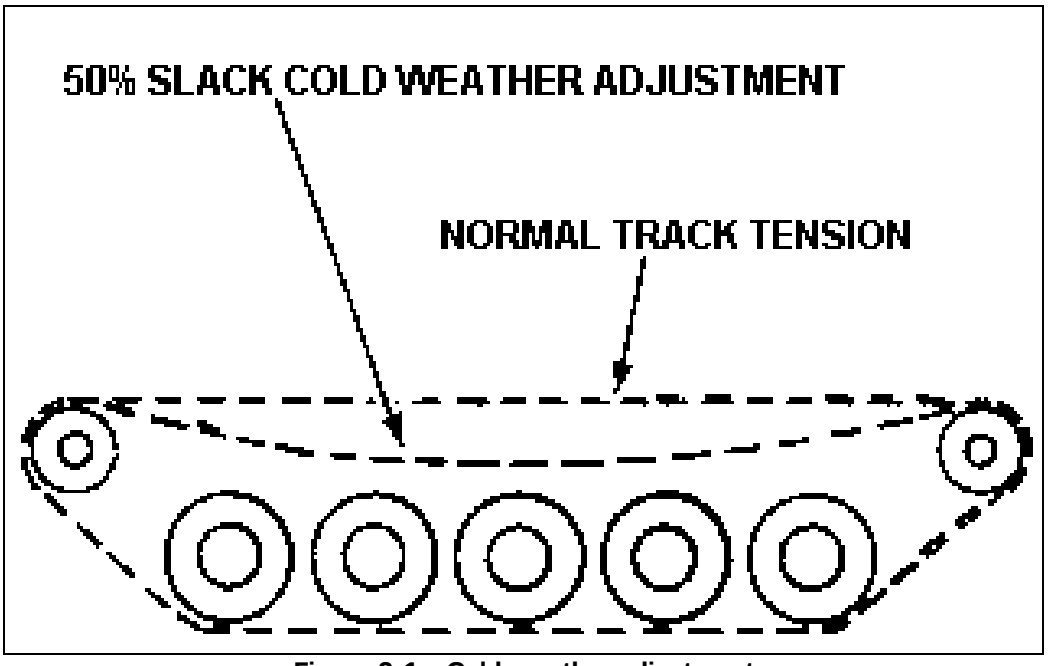

Figure 2-1. Cold weather adjustment

For the M-1 series tanks with T158 track, special ice cleats are available. For best performance, every fifth track shoe should receive a set of cleats. A total of 64 cleats per vehicle (32 per side) and 64 new self-locking nuts are needed. These cleats are for the T158 track only; they will not work with the T156 track. Also, cleats are not yet available for the T156 track.

Tires

At -50°F tires become rigid enough to support a load at 0 pressure without apparent deflation. Sidewalls become brittle and crack. Valve stems on tubes can break if the tires are under-inflated and the tires rotate on their rims. Check valve stems and tighten cores. Replace cores if rubber seals are brittle or show wear. Examine tire casings for cuts, bruises, or breaks. Caps must be installed on all valve stems. Increase tire pressure about 10 PSI, as shown in the TM, to compensate for the cold effects on tires for overnight or extended parking. Tires should be deflated to proper pressure before operations.

Springs

Springs become brittle and break easily at low temperatures. Clips, leaves, U-bolts, hangers, and shackles must be in good condition and correctly and securely mounted. Spring leaves should not be broken or shifted out of their correct position. Tighten all spring U-bolts, assembly, and mounting bolts securely.

Cab Closures

Cab closures protect soldiers from sub-zero temperatures and wind. Ensure cab closure mountings are secure and in good condition. Replace broken windows, and ensure that closures are tight-fitting.

Fire Extinguishers

Winterize carbon dioxide fire extinguishers IAW the appropriate fire extinguisher TB.

Section II
Power Train

ENGINES

Using ordinary engine oil increases the fluid friction on cylinder walls and bearings to the extent that it may not be possible to crank the engine with an ordinary storage battery. Using lubricating oil (OEA) prescribed for cold weather operation by the LO will prevent this condition during cold starts.

NOTE: OEA engine oil is listed as OES in some older LOs. Equipment being prepared for future cold weather operation must use arctic-type lubricants, even if considerable operation in warmer climates is involved prior to cold weather operation. This eliminates disassembly of components for lubrication when low temperatures are encountered.

General procedures for preparing the lubrication system for cold weather are as follows:

- If possible, store lubricating oils and grease in a warm place. Lubricants are much easier to pour or apply if they are warm. Prevent snow or moisture from entering the crankcase when lubricants are added. Use only newly opened cans of oil to eliminate the possibility of using contaminated oil.

- Keep lubricating equipment free of moisture, snow, ice, or dirt to avoid contamination.

- Inspect the engine oil pan and gasket for leaks.

- Drain the engine lubrication system when warm. Replace the oil filter element. When the system is clean, fill with lubrication oil (OEA) in the amount specified in the operator TM or LO. Run the engine for 10 minutes and check for oil leaks. Stop the engine and wait 1 to 5 minutes before checking the oil level. This reading will be approximate only and should be between the ADD and FULL marks. This is due to the many oil passages of the engine.

- When a temporary rise in temperature occurs, drivers should not change or vary their operation of the vehicle. Lubricant levels and points, however, should be closely observed, and proper steps taken to replenish lubricants. Instructions in LOs apply when a definite change to higher environmental temperatures is expected, such as a change of seasons (Table 2-1).

NOTE: When engine oil (SAE 10 or OE/HD010) is prescribed for gear cases, drain and fill with lubricating oil (OEA) or gear oil (G075) as prescribed by LO.

TRANSMISSIONS/TRANSFER CASES/DIFFERENTIALS/FINAL DRIVES

All transmissions should be drained, flushed, and completely refilled with lubricant prescribed in the LO. Some LOs require the use of Dextron III in the transmission. In cases where the prescribed lubrication is not readily available in the supply system, units may have to local-purchase the required lubrication.

COOLING SYSTEMS

Operators need to constantly check the engine's operating temperature. A cooling system should be able to reach 160° to 180°F no matter how cold it is outside.

Liquid Cooling System

For temperatures of 32°F and colder, cooling systems are protected with antifreeze compound, ethylene-glycol, inhibited, heavy-duty single package (MIL-A-46153).

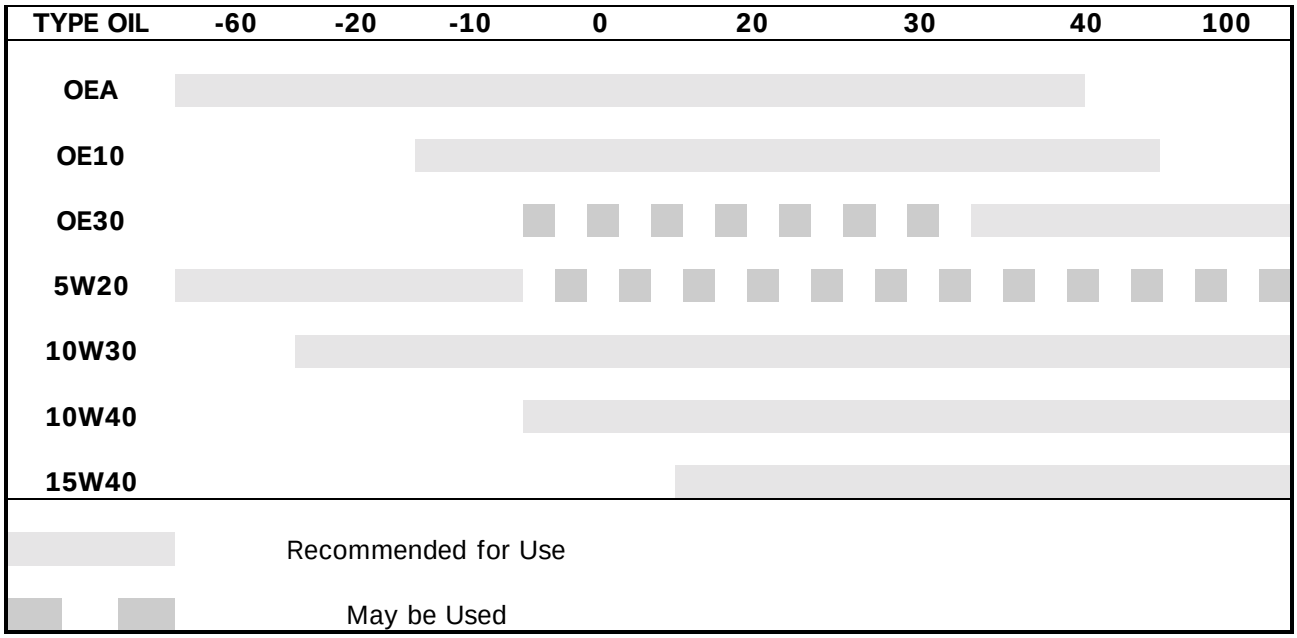

Table 2-1. Engine recommended temperature range (F)

Cooling systems containing no ethylene-glycol-water or arctic antifreeze solutions should be drained and flushed, if required, before the onset of freezing temperatures. Soldiers should then add the correct antifreeze solution. Propylene glycol-based antifreezes available commercially should not be mixed with ethylene glycol-based antifreeze.

CAUTION
IT IS ESSENTIAL THAT ANTIFREEZE COMPOUNDS BE KEPT CLEAN. USE ONLY CONTAINERS AND WATER THAT ARE FREE FROM DIRT, RUST, AND OIL.

Procedures

When drain plugs have been removed, or drain cocks opened to remove liquid from the cooling system of any equipment, the drains should be inspected to ensure none are obstructed. If any drain hose has become obstructed by foreign material, use a soft wire to clear the obstruction and permit complete drainage.

Before adding antifreeze compound, the cooling system must be clean and completely rust-free. The system should be cleaned with cleaning compound IAW TB 750-651.

Inspect/replace all deteriorated cooling system hoses and radiator cap gaskets. Inspect and tighten hose clamps, plugs, and petcocks. Repair radiator leaks before adding antifreeze compound. Correct any exhaust gas or air leakage into the cooling system.

If there are signs of coolant leaks at the cylinder head, check cylinder head nuts for torque as specified in the applicable TM. Replace the cylinder head gasket if necessary. On some vehicles, the torquing of head bolts and replacement of head gaskets is the responsibility of direct support (DS) or general support (GS) maintenance. Check the applicable TM.

If the engine does not reach normal operating temperature, inspect the thermostat to see that it closes completely. Look for evidence of sticking in open or closed position. Replace the thermostat if it does not open or close completely or does not function freely. Where average temperatures are between 0° and -65°F, a +190° to +195° thermostat should be installed in cooling systems that use a 150°F thermostat for normal operations.

If premixed antifreeze is not available, use Table 2-2 as a guide for mixing. The antifreeze should then be tested with a hydrometer or the view-type tester (Figure 2-2).

The antifreeze tag should read: THIS COOLING SYSTEM IS FILLED WITH ETHYLENE-GLYCOL ANTIFREEZE SOLUTION. PROTECTS TO -40°F (or whatever the correct protection temperature should be); or, THIS COOLING SYSTEM IS FILLED WITH ARCTIC-TYPE ANTIFREEZE. PROTECTS TO -90°F. CAUTION: DO NOT ADD WATER OR ANY OTHER TYPE OF ANTIFREEZE.

Record the condition of the cooling system and the degree of freeze protection in maintenance records.

PROTECTION TABLE

Cooling System Capacity in Quarts	ANTI-FREEZE COOLANT REQUIRED IN QUARTS For Protection to temperature Points °F Shown Below											
	2	3	4	5	6	7	8	9	10	11	12	13
5	-12°	-62°										
6	0°	-34°										
7	6°	-17°	-54°									
8	10°	-7°	-34°	-69°								
9		0°	-21°	-50°								
10		4°	-12°	-34°	-62°							
11		8°	-6°	-23°	-47°							
12		10°	-0°	-15°	-34°	-57°						
13			3°	-9°	-25°	-45°	-66°					
14			6°	-5°	-17°	-34°	-54°					
15			8°	0°	-12°	-26°	-43°	-62°				
16			10°	2°	-7°	-19°	-34°	-52°				
17				5°	-4°	-14°	-27°	-42°	-58°			
18				7°	0°	-10°	-21°	-34°	-50°	-65°		
19				9°	2°	-7°	-16°	-28°	-42°	-56°		
20				10°	4°	-3°	-12°	-22°	-34°	-48°	-62°	
21					6°	0°	-9°	-17°	-28°	-41°	-54°	-68°
22					8°	2°	-6°	-14°	-23°	-34°	-47°	-59°
23					9°	4°	-3°	-10°	-19°	-29°	-40°	-52°
24					10°	5°	0°	-7°	-15°	-24°	-34°	-46°

Guide for Preparation of Ethylene-Glycol Antifreeze Solutions

Do not use without some water; 68% concentration gives maximum protection. Use at least 25% concentration for protection against rust and corrosion.

Table 2-2. Antifreeze mixing guide

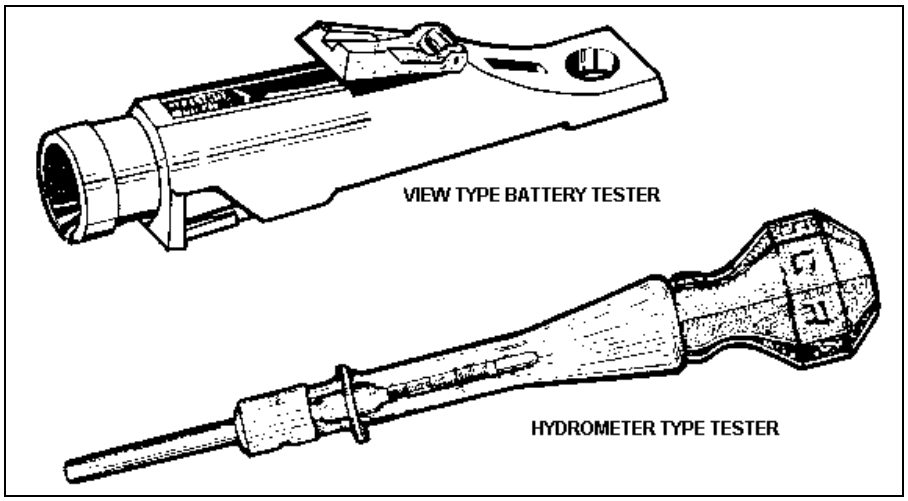

Figure 2-2. Antifreeze testing devices

Air-cooled System

Since an air-cooled system does not use a liquid coolant, it is often assumed that air alone acts as the cooling medium. This is not true. The lubrication system also helps in cooling the engine and transmission. It often includes oil pumps that circulate the oil between the engine and the coolers and between the transmission and the coolers, removing heat from the engine and transmission. Some engine cooling also results from the fuel contacting metal parts prior to combustion.

The effects of cold on an air-cooled system are basically the same as the effects on the engine lubrication system.

FUEL SYSTEMS

For a satisfactory start, engine fuel must be volatile enough to produce a combustible mixture with air. Atomization, which increases the rate of vaporization of the fuel to produce a combustible mixture, is adversely affected by low temperatures. The maximum amount of vaporization obtainable with the regular grade of motor fuel--without the use of a primer or application of heat to the mixture--provides only enough vaporized fuel for starting at a minimum temperature of 0°F.

Diesel engines are particularly difficult to start in cold weather. Many fuels, such as DF-2, contain waxes that congeal at temperatures below 0°F. If this occurs, the filter will clog and the fuel will not flow. Diesel fuel, arctic (DFA) grade, does not contain as much wax and performs well in cold regions. JP-8 is a good low temperature diesel fuel; however, check the TM to make sure it can be used without excessive fuel injector pump wear.

Water accumulates in tanks, drums, containers, fuel pumps, and carburetors because water from the air condenses. At low temperatures, this water forms ice crystals that clog fuel lines, fuel filters, fuel pumps, injector nozzles, and carburetor jets.

NOTE: Fuel filters should be cleaned or changed at frequent intervals. Conditions may require daily cleaning under field use. Take special care to ensure 5-gallon fuel cans used in refueling are clean and serviceable. Fuel nozzles should be complete with filters.

Follow the instructions listed below to prepare fuel systems for operation in cold weather. Drain fuel systems and refill with

arctic-grade fuel. Add inhibitor, icing, fuel systems (ethylene glycol monomethyl ether) to diesel fuels and add methanol, technical, to gasoline. Mix additives with the fuel, normally at a ratio of one pint of additive to 40 gallons of fuel, prior to refueling (Table 2-3).

NOTE: Using additive in greater proportions than two pints of additive to 40 gallons of fuel results in poor engine performance and possible engine damage.

Remove and service all engine and air compressor air cleaner elements, including oil-bath type. Clean with dry-cleaning solvent and reinstall. Fill oil-bath type cleaners with OEA. Dry-type air cleaners, both felt and paper, should be cleaned with either low pressure air or soap and water. When soap and water or dry-cleaning solvents are used, air cleaners should be dried thoroughly before reinstallation.

Check for any indication of fuel leaks. Trace all leaks to their source and correct or replace parts.

UNIVERSAL AND SLIP JOINTS

Thoroughly lubricate joints with grease, molybdenum disulfide (GMD). Remove dirt and ice and check for good condition.

FUEL	REQUIRED ADDITIVE	FUEL TEMP RANGE F°
MOGAS	Methanol, Tech.	ALL
DIESEL		
DF2	Ethylene, Glycol, Monomethyl, Ether	Above 25
DF1	Glycol, Monomethyl, Ethylerne, Ether	25 to -25
DFA	Ethylene, Glycol, Monomethyl, Ether	Below -25
JP8	Ethylene, Glycol, Monomethyl, Ether	Below -25

Check for any indications of fuel leaks. Trace all leaks to their source and correct or replace parts as necessary.

Table 2-3. Fuel and additive mixtures

Section III
Electrical System

SPECIAL CONCERNS

The drive mechanisms of starters are extremely susceptible to failure at low temperatures. Grease or dirt on the armature shaft, bendix drive, or other type of mechanical drive prevents gears from meshing properly. It can also cause them to remain in mesh after the engine is started, damaging the starter. An improper lubricant on bushings can congeal and cause the starter to operate poorly by placing an excessive drag on the armature. Solenoid plungers, unless clean and free of oil, bind in switch assembly housings. Oil and grease on brushes or commutator prevent the good contact needed to carry the large amount of current required to crank an engine.

The breaker contact-arm bushing can freeze on its pivot if it is not clean and properly lubricated. This freezing prevents the breaker arm from returning when the cam separates the points. Improper oil or excessive dirt causes automatic advance mechanisms on distributors to become inoperative. Other problems may include--

- Ice caused by condensation coats spark plugs and may prevent starting of engines.

- Oil or dirt on brushes or commutator causes unsteady or low generator output.

- Lubricant congealing in bushings at low temperatures causes electric heater motors to operate poorly.

- Insulation on low and high tension cables cracking. Besides being a safety hazard, this condition can impair overall performance.

SYSTEM PREPARATIONS

The following procedures prepare the electrical system for cold weather operations:

- Storage battery capacity is greatly reduced at low temperatures because the electrolyte is less active. To prevent freezing, operators must keep batteries fully charged. Check specific gravity of the electrolyte to determine the state of charge of the battery.

- To test specific gravity, the visual battery/antifreeze tester is one of the best products available. This tester is designed specifically for rapid and accurate checking of battery charge and permanent antifreeze protection. Only a few drops of electrolyte or coolant are needed for an accurate reading. A separate tester is required for propylene glycol antifreeze compared to ethylene glycol antifreeze.

- To test battery electrolyte, close the plastic cover and put a few drops of the electrolyte onto the measuring surface through opening in cover.

- Point the tester toward a bright light and look into the eyepiece. Read the scale on the left side. The liquid sample divides the scale showing light and dark areas. Read the scale at the dividing area. The tester automatically corrects for temperature.

Another method of checking specific gravity is with a battery hydrometer. The hydrometer uses a float to measure the density of the electrolyte. However, the float only measures the actual density of the solution; it does not take into account the temperature variations that make the electrolyte contract and expand. In cold weather a specific gravity reading must be corrected to a temperature of 80°F. The normal correction for temperature is 4 (0.004) points of specific gravity for each 10°F change in temperature of electrolyte above or below 80°F.

To minimize starting problems in temperatures below 0°F, ensure that batteries are initially filled with electrolyte of 1.280 specific gravity. TM 9-6140-200-14 gives specific information for the mixture of electrolyte. A battery apparently fully charged according to a hydrometer reading (actual reading 1.280) is, in reality, only half charged at -60°F when the specific gravity reading is corrected to 80°F (corrected reading 1.220). A battery should be above 20°F to deliver sufficient current for starting.

If the vehicle is equipped with a battery heater, it must be operated IAW instructions supplied with the winterization kit. If no winterization equipment is installed on the vehicle, the battery can be heated by removing the battery and placing it in a heated room, or by directing hot air on it from a portable heater. (Sufficient time must be allowed to warm battery internally.) Some vehicles, such as the M1 Abrams tank, have exposed batteries that are not heated. These batteries will not fully charge in operation; over time, they will need to be heated and recharged in a maintenance shop to maintain reliable starting.

CAUTION

ADD WATER TO BATTERY ONLY WHEN VEHICLE IS TO BE IMMEDIATELY OPERATED FOR 30 MINUTES OR MORE.

Section IV
Auxiliary Equipment

AIR COMPRESSORS

An air compressor is an engine-driven device used to compress air to predetermined and controlled pressures. It is used in vehicle air-brake, air-hydraulic brake, and central tire inflation systems.

Condensed moisture may freeze within the compressor. Follow after-operation maintenance procedures by draining condensation from air compressor tanks. If the bleed valve is frozen, report it immediately to maintenance personnel. Some 900 series vehicles (M911/977) and the new FMTV 2 1/2- and 5-ton trucks use air driers in the air brake system. These system must be checked for frozen vapors in the drip tube. The same system is also used on the PLS and the HET.

Alcohol evaporators, usually found near the air compressors of cargo trucks and semitrailers, should be filled with alcohol during operations in temperatures of -20°F and below. These evaporators are usually plastic bottles of alcohol included in winterization kits. They are designed to draw water out of the air going into the compressor to prevent freezing. Check the container before, during, and after operations.

Air compressors either have their own lubricating system (self-lubricated) or are lubricated from the engine lubrication system. No further preparation is necessary for the engine-lubricated, air-cooled compressor, provided the engine crankcase has been filled with lubrication oil (OEA).

NOTE: If an oil-bath-type air cleaner is used on a compressor, drain the oil, clean, and fill to proper level.

The cooling system of liquid-cooled air compressors is connected to the cooling system of the vehicle engine. Drain, flush, and clean the compressor cooling system and inspect for leaks. Ensure all connections are in good condition. Tighten cylinder head bolts to correct torque tightness specified in the vehicle TM. The engine coolant system must be adequately protected with antifreeze compound. Inspect the compressor for leaks.

AUXILIARY ENGINES AND GENERATORS

The auxiliary engine and generator are operated when batteries are being charged, when auxiliary electrical equipment is being used, while the main engine is not running, or when the current furnished by the main engine is inadequate for the imposed load.

Preparation for Operation

The auxiliary engine, generator, spark plugs, and magneto should be prepared in a manner similar to the main engine and components. Carefully warm the engine block with a swingfire heater, or with the duct from a portable heater, to assist in starting. Many small engines have a summer/winter air intake diverter which allows warm air to be pulled over the exhaust in winter and directly from the outside in summer. If the engine is so equipped, ensure the diverter is set for winter operation.

NOTE: Some small engines have a low oil pressure shutoff switch to stop the engine in case of low oil pressure. The oil in the engine block must be warmed sufficiently so the cranking revolutions per minute (RPM) can build up enough oil pressure to close the switch so the engine will start.

POWER TAKEOFF ASSEMBLIES

Power takeoff assemblies are usually mounted on the side of the transmission, but are sometimes mounted on the side of the transfer. They provide a means for taking power from the engine to operate a chain-driven winch, a hydraulic pump (for hydraulically-operated winch, dump mechanism, or gasoline delivery to tank), or other various auxiliary power-driven machinery (i.e., earth-boring machine and crane). In cold weather, improper lubricants will solidify, making operation of the power takeoff difficult or impossible.

Preparation for Operation

As the power takeoff operates from the transmission or transfer, the lubricant should be that specified for sub-zero temperatures for these units. Drain the gear cases while warm and fill with prescribed grade of gear lubricant.